

12

EUROPEAN PATENT APPLICATION

21 Application number: 83307914.8

51 Int. Cl.³: G 02 B 27/17

22 Date of filing: 22.12.83

30 Priority: 27.12.82 US 453646

43 Date of publication of application:
05.12.84 Bulletin 84/49

64 Designated Contracting States:
DE FR GB NL

71 Applicant: HONEYWELL INC.
Honeywell Plaza
Minneapolis Minnesota 55408(US)

72 Inventor: Abel, Irving R.
1522 Partridge Road
Lexington Massachusetts 02173(US)

74 Representative: Harman, Michael Godfrey
Honeywell Control Systems Ltd. Patent Department
Charles Square
Bracknell Berkshire RG12 1EB(GB)

54 Radiation detector.

57 An optical scanning system (e.g. for infra-red) has interspersed scans of wide and narrow fields of view. The scanning is performed by a rotating scanning mirror drum (32), feeding a linear array detector (34). The narrow field of view is defined by a cassegrainian telescope (16, 18), and the wide field by a telescope (24, 26, 72, 73, 64, 74). The necessary switching between the two fields of view is performed by the drum (32), which has some of its mirror surfaces at one angle to reflect from one telescope to the detector, and others at another angle to reflect from the other telescope to the detector. The two telescopes have a common axis along the axis of rotation of the drum, and two mirrors (24, 26) fold the axis of one telescope to a position parallel to the drum axis. The mirrors are in a 3-1-3-1-3-1 arrangement, giving 3 scans of one telescope for each scan of the other.

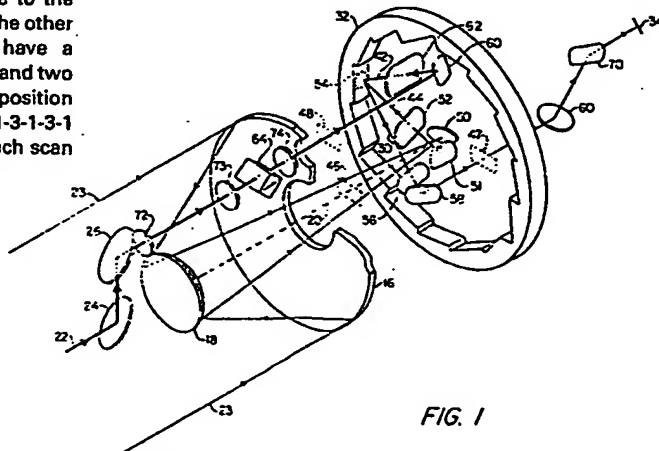


FIG. 1

- 1 -

RADIATION DETECTOR

5 The present invention relates to radiation detectors and in particular to optical scanning systems which provide switching between two viewing modes (for example, between narrow and wide fields of view), e.g., scanning systems used in conjunction with Forward Looking Infrared ("FLIR") imaging devices.

10 The requirement for high performance, low altitude, single piloted aircraft missions has imposed severe demands upon the design of systems for the acquisition and utilization of imagery, particularly infrared or reconnaissance imagery. Typically, such low altitude aircraft sensors must simultaneously provide video information from two different fields of view; a wide field of view for general flying and navigation, and a narrow field of view for target screening and tracking. Although it would be possible to perform both viewing functions by providing two separate sensors, this would require a heavier, larger and much more expensive system. As a result, these constraints on sensor size, volume and detector complexity have resulted in a need for single
20 optical imaging systems which can perform these multiple functions.

In such single optical imaging systems, since neither viewing function requires continuous update, it is possible to time share a common detector array between viewing modes, thereby reducing system complexity and cost. However, to
25 time-share the detectors by means of directing video frames covered by the detectors from one function to the other in a selected sequence, it is necessary to switch the optical axis from one field of view to the other during a small fraction of a frame period. At the same time, it is necessary to scan so that a restricted number of detectors in an ordered array can cover the full field of view in a frame
30 period.

In the past, a single sensor providing both scanning and switching functions has required a separate assembly for
35

each function. For example, in some systems the scanning function has been performed by oscillating a plane mirror, or rotating an external multifaceted mirror or refractive wedges. The function of switching between different optical systems or fields of view has been provided by either a second oscillating plane mirror, a light modulator or a mechanical shutter.

Systems incorporating these types of switch and scan assemblies have numerous disadvantages. First, the use of an oscillating mirror for switching fields of view requires a large drive impulse and a relatively long settling time relative to the duration of the frame period. A light modulator switch is undesirable since it requires increased aperture and/or component size. The use of oscillating mirrors or rotating refractive wedges for scanning is generally undesirable since they are limited in field angle, and are non-linear at wider fields of view. An externally faceted drum type scanning mirror generally requires increased system volume, and is, therefore, less desirable for many applications.

According to the present invention, there is provided scanning apparatus for scanning radiant energy from two fields of view within a scene of interest, comprising switching means for switching between the two fields of view, a rotating scanning mirror drum, and a detector receiving radiation from the selected field of view reflected by the drum, characterized in that the drum includes a plurality of mirror surfaces arranged so that some surfaces reflect radiation from one field of view to the detector and others reflect radiation from the other field of view to the detector, whereby the drum also acts as the switching means.

- 3 -

An embodiment of the present invention will now be described by way of example, with reference to the accompanying drawings, in which:-

5 Figure 1 is an isometric view of the scanning apparatus according to the present invention and in which the optical paths of the narrow and wide field viewing modes, respectively, are shown;

Figures 2A and 2B show cross sections through the drum scan mirror of the apparatus of Figure 1, and

10 Figure 3 is a longitudinal cross section through a sensor utilizing the switch-while-scan mechanism of the apparatus of Figure 1.

Referring to the drawings, the scanning apparatus includes a telescope assembly 10, switch/scan optics 12, and an
15 optical detector device 14.

In the described embodiment, telescope assembly 10 includes narrow and wide field objectives located about a common optical viewing axis 20. The narrow field objective takes the form of a cassegrainian telescope comprising an annular
20 primary mirror 16, and primary and secondary mirror 18 in order to produce a compact assembly. To incorporate a second, wide-field objective while maintaining line of sight compatibility between the two viewing modes and minimizing narrow field obscuration, beam 22 from the scene of interest
25 is directed initially along the sensor axis 20, then turned approximately ninety degrees by fold mirror 24. Such beam is then turned by a second fold mirror 26 into scanner optics 12. The beam between mirror 26 and optics 12 is substantially parallel to the sensor axis 20. Light collected
30 by the narrow field telescopic objective enters the switch/scan optics 12 directly along optical axis 20; and light collected by the wide field objective enters the optics 12 along a second axis 28, which is substantially parallel to the axis 20, but is displaced by a distance which may be
35 approximately ninety percent (90%) of the radius of a multifaceted scanning drum 32 of optics 12. As a result of the

unique geometry of the internally directed facets of drum 32 coupled with the rotation of the drum above axis 20, the axes of the two telescopes or viewing modes are made coincident such that they emerge along a common exit port axis 30 which enters the detector device 14. The detector optics 56 and 58, as shown in Figure 1, are arranged so as to minimize volume requirements within the housing of the sensor and to accommodate the motion of the gimbals, if necessary.

A scan of linear detector array 34 within detector device 14 is provided in order to create a two dimensional image ("frame") each time that a facet of drum 32 crosses incident radiation beams 22 or 23. Thus, with a 12-facet drum 32, as shown, by way of example, in Figures 2A and 2B, there are twelve frames of images produced for each rotation of the drum. The mirror facets of drum 32 are sequenced in angular tilt such that, for example, for three successive facets 37, 38 and 39, light 22 collected by the wide field optics along axis 42 will be reflected along axis 30 to the detector device 14; then for one facet 40, light 23 collected by the narrow field optics along axis 44 will be reflected along axis 30 to detector device 14. By the example shown, this sequence is then repeated two more times during one complete revolution of drum 32. While rotating uniformly, drum 32 is scanning and switching at a rate determined by the overall system requirements. For the normal television rate of 30 frames/second, the 12-sided drum must rotate at 2.5 revolutions per second (rps), which is slow enough so that perturbation to the sensor from aircraft motion is negligible.

It is understood that the frame update requirements, as well as other system parameters, will affect the size, number and sequencing of facets on the drum mirror 32. There is, however, great flexibility in the choice and sequencing of wide and narrow fields of view.

The scanner optics 12 may include all elements contained within the cylinder defined by the outer surface of the

- 5 -

drum mirror 32. There are two entrance ports on the telescope side of the system. As shown in Figure 3, the narrow field port 46 is located on axis 20 of drum 32; and the wide field port 48 is located at some outer radius, as shown.

5 Light entering the narrow field port 46 is folded by two plane mirrors 50 and 51 and then collimated by a lens 52 so as to fall on a specified facet of the drum 32 as designated by the optical pupil 54. The mirror facet 40 reflects the radiation to an exit lens 56 followed by a fold mirror 58,
10 which directs the radiation out of the single exit port 47 of the drum 32.

Radiation entering the wide field port 48 is reflected by fold mirror 60 to a collimator lens 62. After collimation it is then reflected from the mirror facet 37, 38 or 39
15 in the specified direction from beam crossing. Upon reflection from the facet, the radiation propagates to the focusing exit lens 56 and then to fold mirror 58 which directs the radiation through the exit port 47.

The action of the rotating scanner drum in the example
20 of a 12-sided drum with a 3,1,3,1,3,1 facet sequence is to reflect radiation from the outer entrance port 48 to the exit port 47 for three (3) frames, switch to radiation from the axial entrance port 46 for one (1) frame, and then repeat the sequence. Other sequences are possible. In a 12-
25 sided (faceted) drum, the sequence could also be 5,1,5,1 or for a 10-sided drum, it could be 4,1,4,1. In addition, more than two fields of view may be viewed. For example, in a 24-sided drum, the sequence could be 2,6,4,2,6,4.

The telescope assembly 10, illustrated in Figure 3, provides narrow and wide field coverage for target screening
30 and pilotage or other functions, as required. Both telescopic subassemblies might be enclosed by a nearly hemispherical window 65 attached to the sensor housing, as shown. The volume enclosed by the window 65 and the housing might
35 also include a 3-gimbal support for the optical system, detector assembly, and associated electronics which could

- 6 -

provide stabilization and pointing relative to inertial coordinates.

5 To provide stabilization and pointing with respect to aircraft coordinates, the wide-field line of sight may be effectively decoupled from narrow field pointing and stabilization. This might be accomplished by supporting plane mirror 24 in a two-axis gimbal in order to nullify the effect of the overall three-axis gimbal movements.

10 In the narrow field objective system the cassegrainian configuration of mirrors 16 and 18 is made specially compact to meet spatial constraints, and its radiation output converges toward a primary focus 67 located close to the entrance port 46 of the drum 32 (see Figure 3).

15 In the wide field system, the radiation is transmitted through the window 65 and then reflected vertically by the gimballed fold mirror 24. The optical axis extends vertically to the outer periphery and then folded ninety degrees by mirror 26 so as to pass through entrance port 48.

20 The wide-field objective may include a stabilization and pointing mirror, a primary objective lens 72, and a relay unit made up of a fold mirror, a prism derotator 64, and transfer lenses 73 and 74. The relay unit is designed to minimize its cross-sectional area and hence its obscuration to the narrow field system.

25 The derotator 64, which must present in its design an odd number of reflections, could comprise a Pechan, Dove, or double Dove prism.

30 The detector assembly 14 might comprise any other combination of lenses and fold mirrors and a detector array necessary to collect each frame of information, while minimizing overall system size and to maximize detector efficiency.

CLAIMS

1. Scanning apparatus for scanning radiant energy from two fields of view within a scene of interest, comprising switching means for switching between the two fields of view, a rotating scanning mirror drum (32), and a
5 detector (34) receiving radiation from the selected field of view reflected by the drum, characterized in that the drum (32) includes a plurality of mirror surfaces (37-40) arranged so that some surfaces (37-39) reflect radiation from one field of view to the detector
10 and others (40) reflect radiation from the other field of view to the detector, whereby the drum also acts as the switching means.
2. Scanning apparatus according to Claim 1, characterized in that the two fields of view are determined by two
15 respective optical systems, one (16,18) being a narrow field of view telescope and the other (72,73,64,74) being a wide field of view telescope, having a common axis, one of the optical systems including two fold mirrors (24,26) which produce its output on an axis
20 separate from and parallel to that of the output of the other optical system.
3. A scanning system according to Claim 2, characterized in that the common axis (20) is the axis of rotation of the drum.
- 25 4. A scanning system according to either of Claims 2 and 3, characterized in that the narrow field of view optical system is a cassegrainian system.
5. A scanning system according to any previous Claim, characterized in that the drum has inwardly reflecting
30 mirror surfaces.
6. A scanning system according to any previous Claim, characterized in that the detector is a linear array of detector elements.

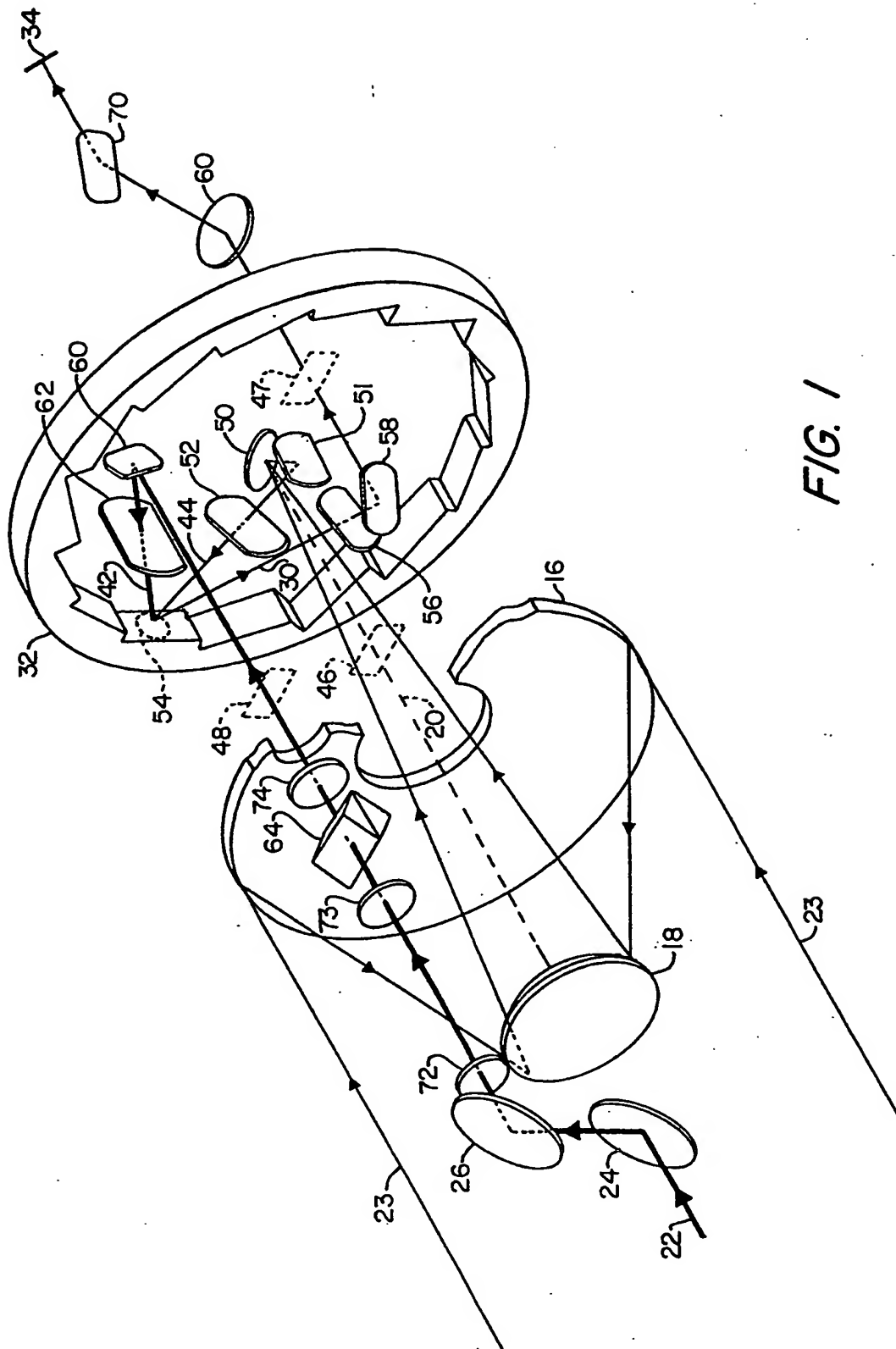


FIG. 1

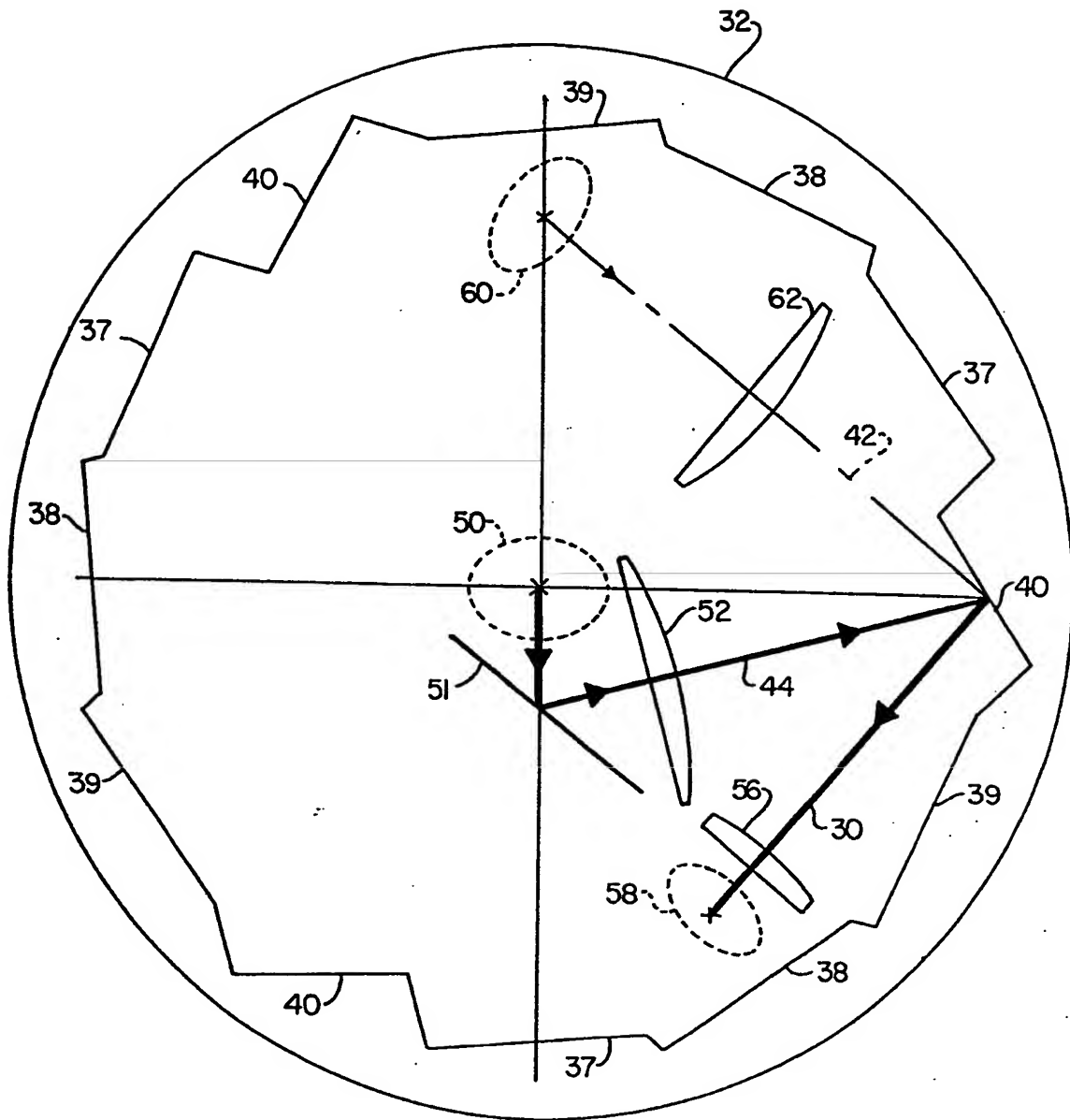


FIG. 2A

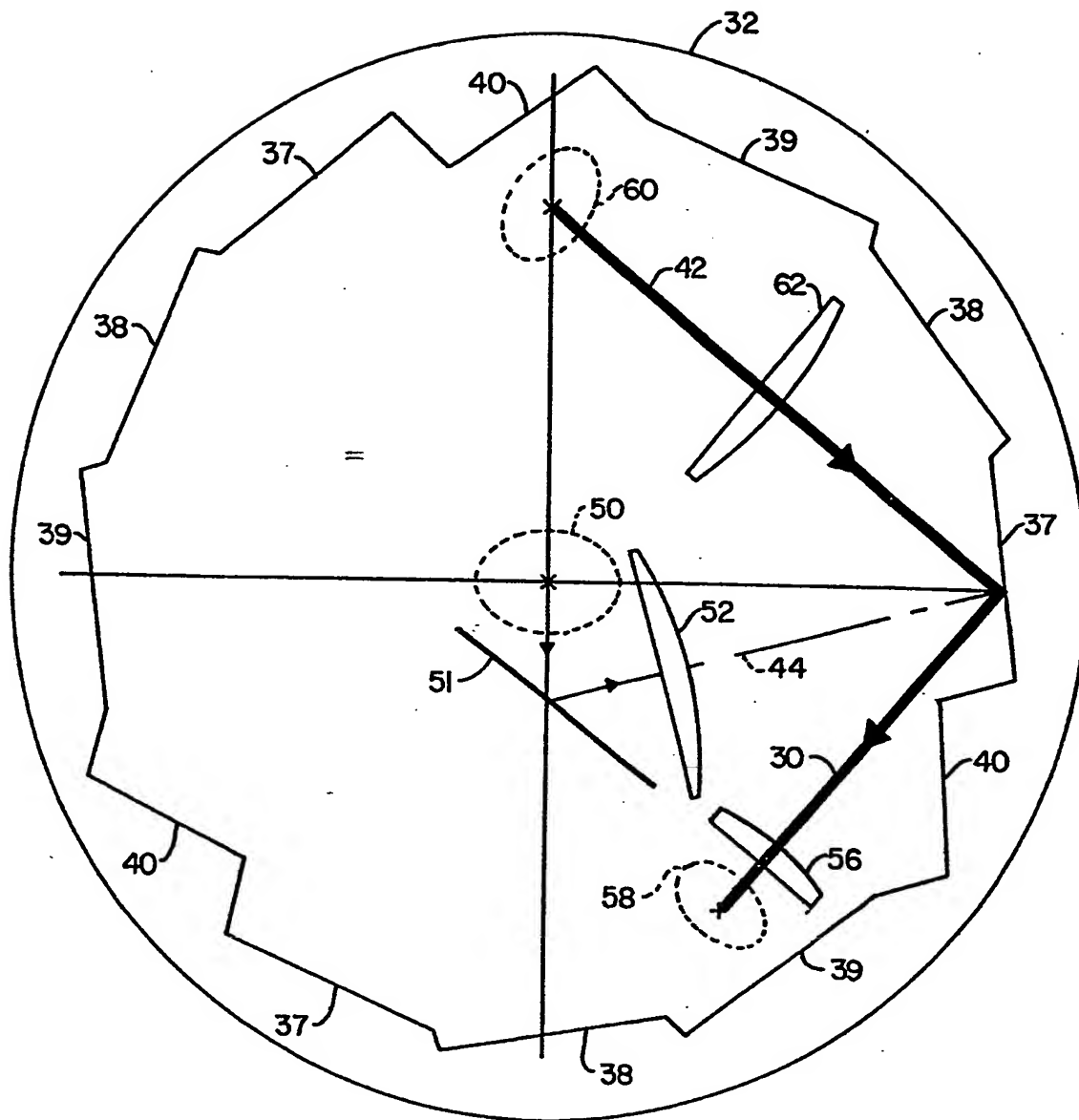
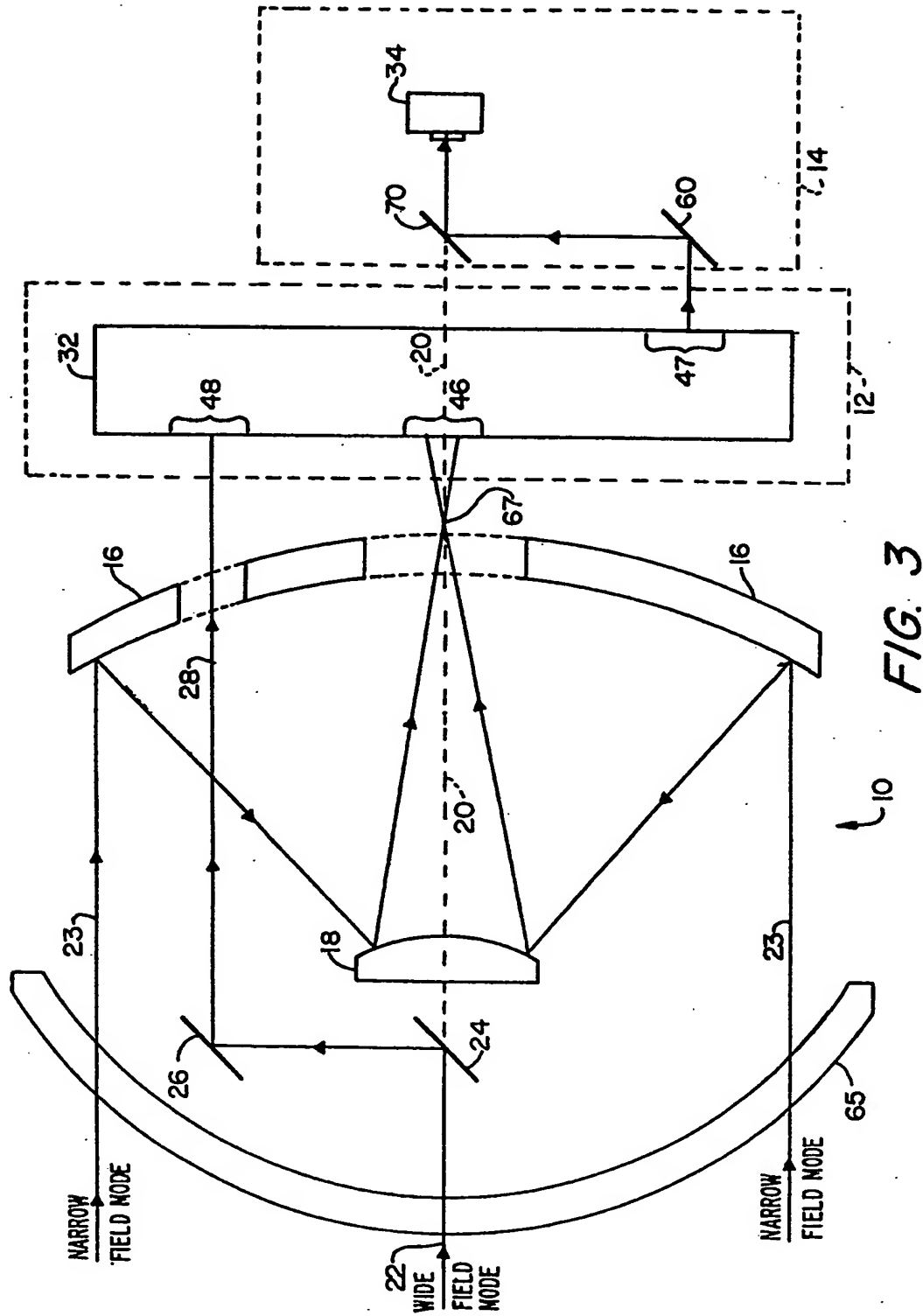


FIG. 2B





European Patent
Office

EUROPEAN SEARCH REPORT

0126826

Application number

EP 83 30 7914

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 7)
A	US-A-2 949 055 (H. BLACKSTONE) * Claim 1 *	1	G 02 B 27/17
A	US-A-4 140 363 (D.A. DAVIS et al.) * Abstract *	1	
A	US-A-3 924 937 (J.L. MUNROE et al.) * Figures 2, 5 *	1	
A	EP-A-0 040 973 (KONISHIROKU PHOTO INDUSTRY) * Claims 1-3 *	1	
A	US-A-2 967 211 (H. BLACKSTONE et al.) * Figure 5; column 6, line 74 - column 7, line 6 *	5, 6	TECHNICAL FIELDS SEARCHED (Int. Cl. 7) G 02 B 27/17 H 04 N 3/08
The present search report has been drawn up for all claims			
Place of search BERLIN		Date of completion of the search 28-03-1984	Examiner FUCHS R
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	